MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2022/2023

ERE1036 – BASIC ELECTRONICS

(All Sections / Groups)

2 OCTOBER 2023
2.30 p.m. - 4.30 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 5 pages including the cover page. There are 4 questions in this final exam.

2. Attempt **ALL** questions. The distribution of marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) An extrinsic semiconductor is formed by doping impurities in it.

(i) Describe how the extrinsic silicon semiconductor N-type are formed and explain how they provide free carriers (electrons) to become more conductive compared to its intrinsic semiconductor. Sketch its diagram in atomic structure.

[5 marks]

(ii) Sketch the energy diagram for these extrinsic semiconductors and explain the difference between energy diagram of instrinsic semiconductors.

[5 marks]

(b) Pentavalent impurities with $N_D = 9.5 \times 10^{17}$ cm^{-3} is doped into germanium semiconductor at temperature T = 300 K. Given the intrinsic carrier concentration, $n_i = 2.5 \times 10^{13}$ cm^{-3}, the germanium electron and hole mobilities are $\mu_n = 3900$ cm^2/V-s and $\mu_p = 1600$ cm^2/V-s at room temperature.

(i) Determine the majority and minority carriers of this extrinsic semiconductor by making an appropriate assumption.

[4 marks]

(ii) Determine the conductivity and resistivity of this extrinsic sample.

[4 marks]

(c) A circuit with a diode is shown in Figure Q1. Given resistor $V_S = 15$V, $R = 5$ kΩ, $V_\gamma = 0.7$ V, and $R_f = 20$ Ω.

(i) Draw the *piecewise linear diode model* to represent the diode D1 in the circuit. Determine the diode current, I_D. [4 marks]

(ii) Calculate the voltage drop at R_f, and determine the actual V_D value.

[3 marks]

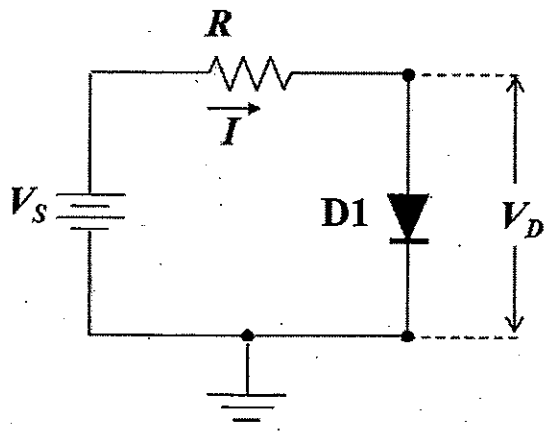

Figure Q1

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Question 2

(a) Figure Q2(a) shows a rectifier circuit with a step-down transformer in which the turn ratio n is 80:10. The transformer's primary supply source, *Vp* is 160V with 60 Hz. Given the output resistance, R_L is 4.7kΩ, and the voltage drop across forward-biased diode D is 0.7 V.

(i) Determine the secondary voltage, *Vs(rms)*. Then find its peak voltage, *Vs(max)* and the peak output voltage, *Vo(max)*.

[2+2+2 marks]

(ii) Determine and the average output voltage, *Vo(av)* and average load current, *Io(av)*. [2+2 marks]

(iii) Determine the RMS output voltage, *Vo(rms)* and RMS load current, *Io(rms)*. [2+2 marks]

(iv) Determine the peak-to-peak ripple output voltage *Vr(pp)* if capacitor C=470μF. Sketch the waveform of the output voltage *Vo* and label the values. [2+4 marks]

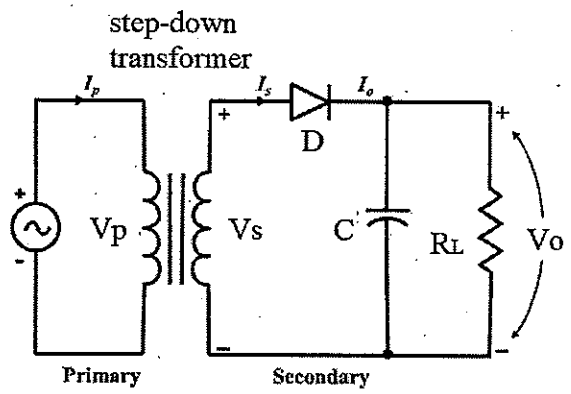

Figure Q2(a)

(b) Design a limiter circuit using Silicon diode(s), Germanium diode(s) and 100Ω resistor to provide an output signal which is clipped as per the followings voltages in Figure Q2(b). Given that Silicon diodes have a cut-in voltage of 0.7V and Germanium diodes 0.3V.

[5 marks]

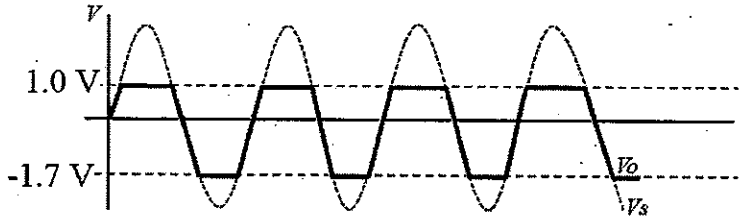

Figure Q2(b)

Continued...

Question 3

(a) Draw the IV characteristics graph for a common-emitter amplifier configuration of bipolar transistor (BJT). Determine the DC load line **end-point** (I_C-sat and V_{CE}-cutoff) at the I_C and V_{CE} axis, respectively, and sketch this load line across the graph. Choose an overlapped node between BJT characteristic line and the DC load line to indicate an operating Q point and label I_{BQ}, I_{CQ} and V_{CEQ} in the graph. Show all the calculation steps to determine the DC load line **end-point** (I_C-sat and V_{CE}-cutoff).

[10 marks]

(b) Figure Q4 shows a common-emitter amplifier with voltage divider bias:

(i) Draw the DC equivalent circuit of the amplifier circuit. [3 marks]

(ii) Calculate the Thevenin equivalent bias voltage V_{TH} and its equivalent resistance R_{TH} for the voltage divider bias. [4 marks]

(iii) Draw the Thevenin equivalent circuit of the DC bias of this amplifier by replacing the voltage divider and calculate the base current I_B. [2+3 marks]

(iv) Calculate the emitter voltage V_E, and the voltage across collector resistance R_C, and hence determine V_{CE} using the exact method. [3 marks]

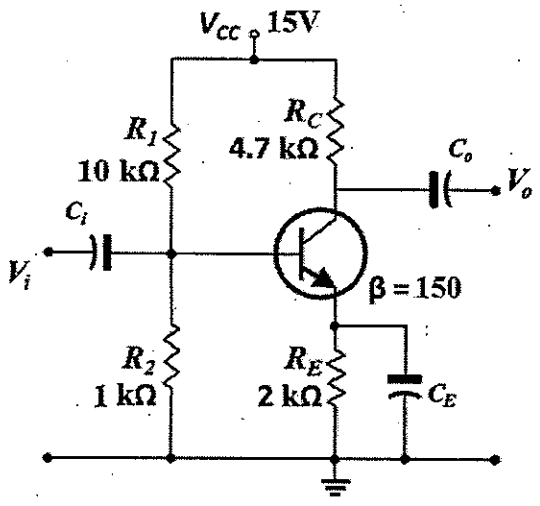

Figure Q3

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Question 4

Figure Q4 shows a BJT common-emitter amplifier circuit, and all the component and parameter values are shown in the table.

(i) Draw the small-signal equivalent circuit for this amplifier using r_e model and label all the known values of its components.

[6 marks]

(ii) Determine whether the approximation method is satisfied.

[4 marks]

(iii) Determine the DC voltage V_B and hence calculate V_E.

[6 marks]

(iv) Determine the emitter current I_E and the internal emitter resistance r_e of the BJT.

[4 marks]

(v) Determine the input impedance Z_{in} and the effective input impedance Z'_{in} seen from the signal generator.

[5 marks]

Component & Parameter	Value
V_{CC}	18V
C_1, C_2, C_3	large
R_1	60 kΩ
R_2	4 kΩ
R_C	6.8 kΩ
R_E	0.5 kΩ
R_S	500 Ω
R_L	1 kΩ
r_o	∞
β	120

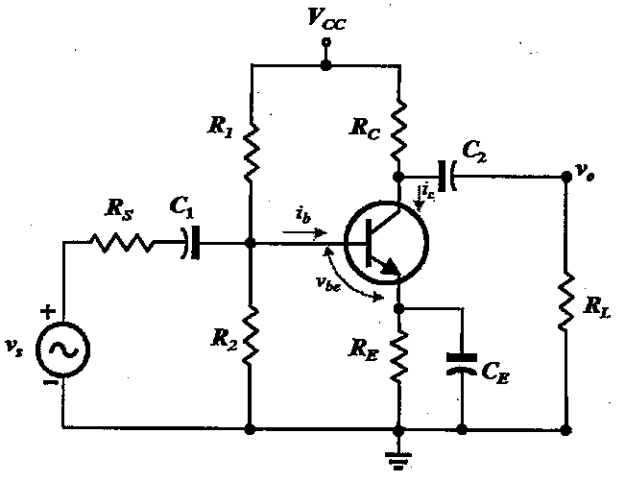

Figure Q4

End of Paper